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RECLAMATION
TEST PLOT REPORTS
1981

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FIGURES

1.1 Tony M Test Plots - Introduction

In their approval of the Notice of Intent for the Tony M/Lucky Strike Mine, the Board of Oil, Gas, and Mining required that test plots be established on mine waste material. Test plot design and siting were completed in 1980. Over 5,000 cubic yards of waste material from the mine was hauled to the site in 1980 and 1981 and allowed to settle, slough, and compact naturally. The plots were divided into "level" and "slope" plots to provide data that will be used to re-vegetate the mines' waste stockpiles upon termination of mining.

1.2 Introduction

The level plots were designed to investigate the effects of different soil amendments on establishment of vegetation. By randomly assigning treatments to a split-split plot design, the study will answer four questions,

1) Do the use of fertilizer and/or mulches and surfactants increase ground cover?
2) Does a straw mulch effect the response to fertilizer?
3) Does irrigation enhance the establishment of ground cover?
4) What effect does time have on the establishment and composition of ground cover?

1.2.1 Treatments

As indicated on the map of the plots, there are four treatments, each of which is divided into subplots with and without straw. The treatments are,

	straw mulch
1) NPK fertilizer	+/-
2) NPK fertilizer + Jacklins Organic Mulch™	+/-
3) NPK fertilizer + surfactant	+/-
4) Control	+/-

Nitrogen, phosphorous, and potassium were applied as Richlawn Dried Poultry Waste (10-5-5) at 2270 lbs/acre. This provided 227 lbs/ac of N, 113 lbs/ac of P, and 113 lbs/ac of K, which met or exceeded the fertilizer recommendations of the Colorado State University Soil Lab for the waste material.

Jacklins Organic Mulch was applied at a rate of 2397 lbs/acre in accordance with recommendations from the company (1 1/2 tons/acre).

Selection of a surfactant which may enhance infiltration rates of the waste material, is yet to be made. Application of this material will follow the first year's irrigation.

Straw was incorporated into the indicated subplots at an application rate of approximately 1 1/2 tons/acre.

The seed mix selected for the study consisted of:

	lbs/acre
Fourwing saltbush (Atriplex canescens)	0.50
Shadscale (Atriplex confertifolia)	0.50
Indian ricegrass (Oryzopsis hymenoides)	3.00
Alkalia sacaton (Sporobolus airoides)	0.25
Sand dropseed (Sporobolus cryptandrus)	0.25
Yellow sweetclover (Melilotus officinalis)	0.50

There are four replications of each of these treatments assigned randomly in each of four blocks. Three of the blocks are irrigated and one is nonirrigated.

A 5 x 5 meter area next to the plots was staked off as a control.

1.2.2 Irrigation

A drip irrigation system was selected for the study, to minimize erosion and water consumption. The system was designed by the Irrigation Systems Co. of Fruita, Co.

The system consists of a 1000 gallon tank, a two horsepower gasoline powered centrifugal pump, pressure regulator, Holly H-50-P filter (150 mesh), one inch PEC line with 1/2 inch laterals, and flipper pressure compensating emitters (one gallon per hour). Layout of the laterals and emitters is represented on the map accompanying this report. The irrigation schedule is dictated by the weather. The following is a schedule which will be followed except for those times when natural precipitation provides ample ground moisture. Each application is approximately one gallon per emitter at a rate of one gallon per hour.

9/30/81-11/19/81	one application per week
11/20/81-3/15/82	no irrigation unless winter is unusually dry
3/15/82-6/1/82	one application per week
6/1/82-9/1/82	three applications per week
9/1/82-11/15/82	one application per week

1.2.3 Sampling and Measurements

Measurements on the plots will consist of: 1) ground cover, and 2) density of plants by species.

Six sampling quadrats (one meter^2 each) were randomly assigned to each treatment plot (three per subplot). The same quadrats will be sampled each time so that the same plant population is studied in each sampling.

Percent ground cover within these quadrats will be estimated and the number and species of plants will be recorded. This nondestructive sampling will leave the plots undisturbed. If the need arises for analysis of plant material at a later date, clippings could be collected from portions of the plots not included in the regular sampling.

Measurements will initially be made at four month intervals, in April, August, and December. This will provide data from the peak season as well as during dormancy.

1.2.4 Statistical Analysis

A split plot analysis of variance will be used to test whether the addition of straw has a significant effect on the fertilizer treatments and if there is a significant difference between treatments.

The data from different years will also be analyzed in a split-split plot deisgn to see what effect time may have on the establishment of vegetative cover.

1.2.5 Preparation, Maintenance, and Monitoring of Plots - 1981

Dumping of the mine waste material was completed in the spring of 1981. The material was left to settle for a few months in order to stabilize the slopes. After this period, the plots were laid out. All corners were marked with iron rebar stakes.

On 7/2/81, the plots were prepared for planting. Straw, Richlawn Dried Poultry Waste, and Jacklins Organic mulch were applied to the designated plots at 3000 lbs/ac, 2270 lbs/ac, and 3297 lbs/ac respectively. These were incorporated into the ground when the straw was crimped in with hand tools.

Seeding followed immediately. The mix described on page (2) was broadcast over the entire study area. The subplots with no straw were then hand raked to incorporate the mulch and fertilizer and to cover the seed. Seed in the subplots with straw remained on the surface.

Installation of the irrigation system on the level plots was completed on 9/23/81. Application of water commenced on 9/30/81 and continued as indicated in the schedule on page two.

SAMPLING QUADRATS FOR TONY M TEST PLOTS

(LEVEL PLOTS)

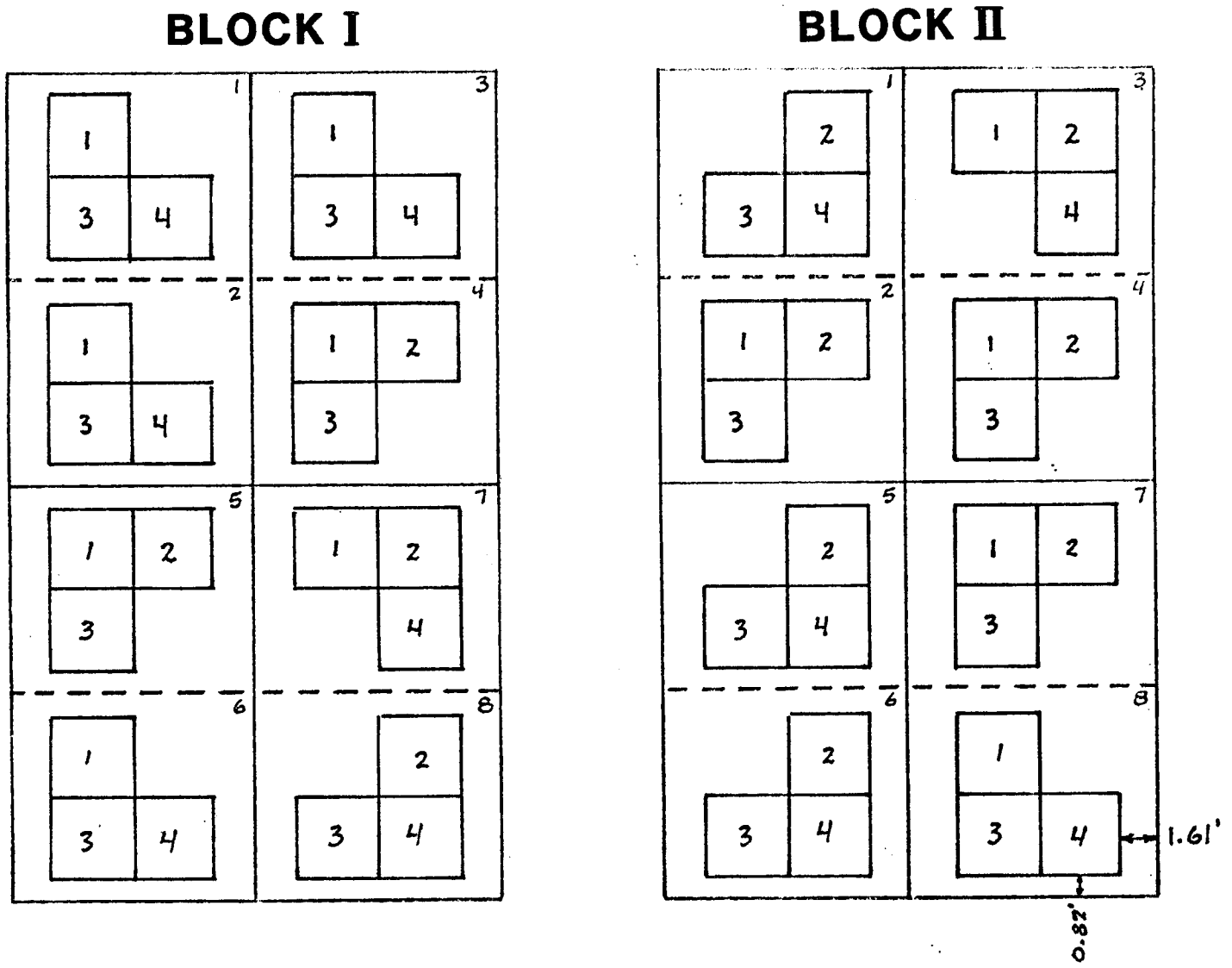
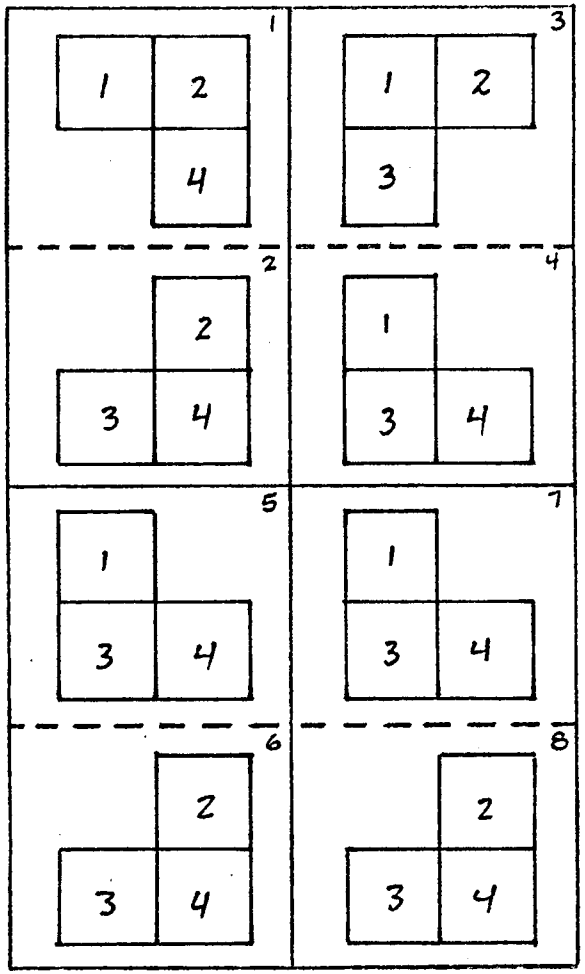


Figure 1.1

SAMPLING QUADRATS FOR TONY M TEST PLOTS

(LEVEL PLOTS)

BLOCK III



BLOCK IV

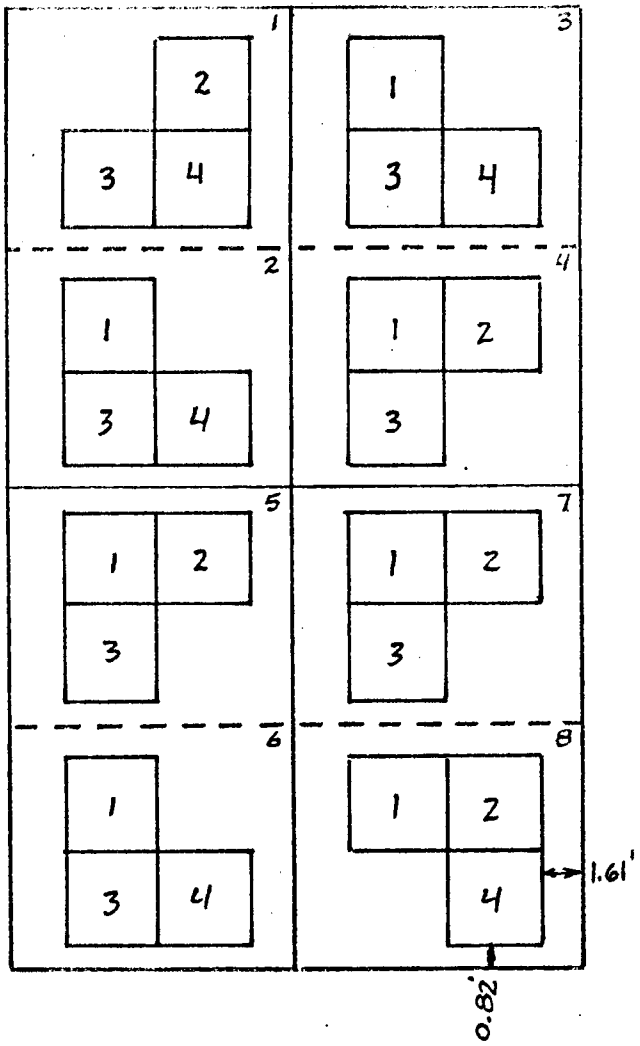


Figure 1.2

TMTP Density by Species/m^2

Quad #	4-wing Saltbush	Shadscale	Indian Ricegrass	Alkalai Sacaton	Sand Dropseed	Yellow Sweetclover		
Subplot 1-1							11	
3							3	
4							17	
Subplot 2-1							0	
3							0	
4							0	
Subplot 3-1							0	
3							1	
4							0	
Subplot 4-1							0	
2							0	
3							0	
Subplot 5-1							18	
2							15	
3							13	
Subplot 6-1							0	
3							0	
4							0	
Subplot 7-1							0	
2							0	
4							0	
Subplot 8-2							16	
3							30	
4							10	

Block # I
Date sampled: 12-14-81
Sampled by: LPR

Notes: All plants on level plots are a grass (presently unidentified) which came up from the straw that was applied.

Figure 1.3

TMTP Density by Species/m^2

Quad #	4-wing Saltbush	Shadscale	Indian Ricegrass	Alkalai Sacaton	Sand Dropseed	Yellow Sweetclover		
Subplot 1-1							0	
3							0	
4							0	
Subplot 2-1							0	
3							0	
4							0	
Subplot 3-1							0	
3							1	
4							1	
Subplot 4-1							20	
2							6	
3							8	
Subplot 5-1							0	
2							0	
3							0	
Supblot 6-1							11	
3							13	
4							14	
Subplot 7-1							9	
2							12	
4							11	
Subplot 8-2							0	
3							0	
4							0	

Block #II
Date sampled: 12-14-81
Sampled by: LPR

Notes:

Figure 1.4

TMTP Density by Species/m^2

Quad #	4-wing Saltbush	Shadscale	Indian Ricegrass	Alkalai Sacaton	Sand Dropseed	Yellow Sweetclover		
Subplot 1-1							2	
3							4	
4							0	
Subplot 2-1							0	
3							0	
4							0	
Subplot 3-1							5	
3							1	
4							2	
Subplot 4-1							0	
2							0	
3							0	
Subplot 5-1							0	
2							0	
3							0	
Subplot 6-1							0	
3							0	
4							0	
Subplot 7-1							0	
2							0	
4							0	
Subplot 8-2							0	
3							0	
4							0	

Block #III
Date sampled: 12-14-81
Sampled by: LPR

Notes:

Figure 1.5

TMTP Density by Species/m^2

Quad #	4-wing Saltbush	Shadscale	Indian Ricegrass	Alkalai Sacaton	Sand Dropseed	Yellow Sweetclover		
Subplot 1-1							1	
3							6	
4							1	
Subplot 2-1							0	
3							0	
4							0	
Subplot 3-1							5	
3							3	
4							2	
Subplot 4-1							0	
2							0	
3							0	
Subplot 5-1							0	
2							0	
3							0	
Subplot 6-1							17	
3							1	
4							4	
Subplot 7-1							0	
2							0	
4							0	
Subplot 8-2							15	
3							11	
4							2	

Block #IV
Date sampled: 12-14-81
Sampled by: LPR

Notes:

Figure 1.6

TONY M TEST PLOT
% Ground Cover

Block I

Subplot #	sampling quadrat 1	2	3	4
1	10		1	10
2	0		0	0
3	3		1	0
4	0	0	0	
5	50	45	25	
6	0		0	0
7	0	0		0
8		10	20	15

Block II

Subplot #	sampling quadrat 1	2	3	4
1		0	0	0
2	1	1	0	
3	0	1		1
4	35	2	5	
5		0	0	0
6		15	5	15
7	10	15	10	
8	0	0		0

Block III

Subplot #	Sampling quadrat 1	2	3	4
1	3	0		0
2		0	0	0
3	3	3	1	
4	0	0		0
5	0		0	0
6		0	0	0
7	0		0	0
8		0	0	0

Block IV

Subplot #	Sampling quadrat 1	2	3	4
1		1	2	1
2	0		0	0
3	5		1	2
4	0	0	0	
5	0	0	0	
6	40		1	1
7	0	0	0	
8	2	1		1

Notes:

Figure 1.7

Date sampled: 12-14-81
Sampled by: LPR

1.3 Introduction

The slope plots are located immediately above the level plots on mine waste which lies at the angle of repose (36°). The uppermost border of the plots is approximately two feet below the top of the slope.

These plots are designed to answer four questions,

1) What differences in survival rates are there between species selected for planting?
2) Is direct placement of transplants more or less effective than seeding?
3) Does irrigation enhance survival rates?
4) What effect does time have on the establishment of ground cover?

1.3.1 Treatments

Seed for the seeded plots was obtained from Native Plants of Salt Lake City, Utah. Species selected were:

Fourwing saltbush (Atriplix canescens)
Shadscale (Atriplex confertifolia)
Rubber rabbitbrush (Chrysothamnus nauseousus)
Indian ricegrass (Oryzopsis hymenoides)

Ten seeds of each species were planted in the center of their respective plots.

Transplants of the same species were obtained from the same source except that Indian ricegrass plants were collected locally.

Planting procedures for the transplants were as follows:

Irrigated Plots - A hole was made in the center of the designated plot into which an Agriform™ starter fertilizer tablet (20-10-5) was placed. The plant was then placed and packed in to one inch above the rooting material. As soon as all plants were in place, the plots were irrigated.

Nonirrigated Plots - The same procedures were followed except that one cup of water was poured into the hole before the plant went in and, another cup was poured on the surface after the plant was in place.

1.3.2 Irrigation

The lateral lines for the slope plots run off of the same system used with the level plots. Emitters were installed on the transplant plots at the same time as the plants were put in. Emitters were placed immediately above and beside the plants (one emitter per plant).

On the seeded plots, the seeds were planted next to the emitters on the downhill side, in the same manner as the transplants. There is one emitter per plot.

The same irrigation schedule described for the level plots will be followed for the slope plots.

1.3.3 Sampling and Measurements

Nondestructive sampling of the slope plots is essential both to protect the plants and the slope, which is very unstable at this time.

The number and relative condition of specimens in each plot will be recorded on the same schedule used for sampling the level plots. These measurements will also include any invading species which may appear.

Erosion on the slope plots will also be closely monitored during sampling and irrigation.

1.3.4 Statistical Analysis

Analysis of variance with a split-split plot in time design will test for significant differences with relation to, 1) species versus species, 2) irrigation versus nonirrigation, 3) transplants versus seeding, and 4) time.

1.3.5 Preparation, Maintenance, and Monitoring of Plots - 1981

Plots were set out at the same time as the level plots, after settling had occured. All corners were marked with iron rebar stakes.

Dates of planting for the slope plots were:

7/7/81	seeded nonirrigated seed plots
9/30/81	put in transplants on irrigated transplant plots
10/1/81	put in transplants on nonirrigated transplant plots
10/5/81	seeded irrigated seed plots

1.3.6 Comments

The waste material on the slope plots is not stable enough to withstand foot traffic without damaging the plants. In setting out the plots, seeding, and installing the irrigation system, as few trips as possible were made across the slope. Monitoring of the plots will have to be done from the bottom of the slope and from the walkways in order to perserve the plants and the integrity of the slope.

Installation of the drip irrigation system proved considerably more time consuming than expected. It appears that the system may allow irrigation of the slope material without servere erosion problems. Some of the emitters however, are erratic in their application of water. This could cause some substantial erosion and otherwise affect the results of the study.

1.3.7 Precipitation and Irrigation Schedule for 1981 (after seeding).

Week ending on:

7/6	no precipitation
7/13	.40" precipitation
7/20	.13" precipitation
7/27	no precipitation
8/2	no precipitation
8/10	no precipitation
8/17	no precipitation
8/24	.32" precipitation
8/31	no precipitation
9/7	.92" precipitation
9/14	.08" precipitation
9/21	no precipitation
9/28	no precipitation
10/5	1 irrigation; 1.71" precipitation
10/12	.08" precipitation
10/19	.34" precipitation
10/26	1 irrigation
11/2	no precipitation
11/9	1 irrigation
11/16	1 irrigation
11/13	1 irrigation
11/30	.69" precipitation (water content of snow)
12/7	no precipitation
12/14	no precipitation

Each application of water by irrigating is approximately equal to one gallon per emitter per hour for a period of 40 minutes.

Irrigated X

Non-irrigated ——

TMTP - Slope Plots (transplants)

SS 1 0 0	IR 1 0	4W 1 0 0	RB 1 0 0	RB 1 0 0	4W 1 0 0	SS 1 0 0	IR 1 0 0
IR 1 0 0	SS 1 0 0	RB 1 0 0	4W 1 1 0	4W 1 0 0	RB 1 0 0	IR 1 0 0	SS 1 0 0
SS 1 0 0	IR 1 0 0	4W 1 0 0	RB 1 1 0	RB 1 0 0	SS 1 0 0	IR 1 0 0	4W 1 0 0
4W 1 0 0	RB 1 0 0	SS 1 0 0	IR 1 1 0	IR 1 0 0	4W 1 0 0	RB 1 0 0	SS 1 0 0
4W 1 0 0	SS 1 0 0	IR 1 1 0	RB 1 1 0	RB 1 1 0	4W 1 0 0	SS 1 0 0	IR 1 0 0
RB 1 0 0	4W 1 0 0	SS 1 0 0	IR 1 1 0	4W 1 1 0	RB 1 1 0	IR 1 0 0	SS 1 0 0

Figure 1.8

SPECIES / CONDITION OF PLANT / EROSION / INVADERS

Condition of transplant
0-dead
1-marginal
2-healthy/new vegetative growth
3-flowering and/or producing seed

Erosion index
0-no significant erosion
1-1-2 small rills
2-several small rills
3-major damage to plot

Date: 12-14-81
Sampled by: CTW

Irrigated ____

Non-irrigated X

TMTP - Slope Plots (transplants)

RB 1 2 0	SS 1 0 0	IR 1 0 0	4W 1 1 0	IR 1 0 0	RB 1 0 0	SS 1 1 0	4W 1 0 0
SS 1 2 0	RB 1 0 0	RB 1 0 0	IR 1 1 0	4W 1 0 0	IR 1 1 0	SS 1 1 0	RB 1 0 0
RB 1 1 0	SS 1 0 0	4W 1 0 0	IR 1 1 0	4W 1 0 0	RB 1 2 0	IR 1 1 0	SS 1 0 0
SS 1 1 0	IR 1 0 0	4W 1 0 0	RB 1 1 0	IR 1 0 0	4W 1 2 0	SS 1 0 0	RB 1 0 0
SS 1 0 0	IR 1 0 0	4W 1 0 0	RB 1 1 0	IR 1 0 0	SS 1 2 0	RB 1 0 0	4W 1 0 0
RB 1 0 0	4W 1 0 0	SS 1 0 0	IR 1 1 0	4W 1 1 0	RB 1 1 0	IR 1 0 0	SS 1 0 0

SPECIES / CONDITION OF PLANT / EROSION / INVADERS

Condition of transplant
0-dead
1-marginal
2-healthy/new vegetative growth
3-flowering and/or producing seed

Erosion index
0-no significant erosion
1-1-2 small rills
2-several small rills
3-major damage to plot

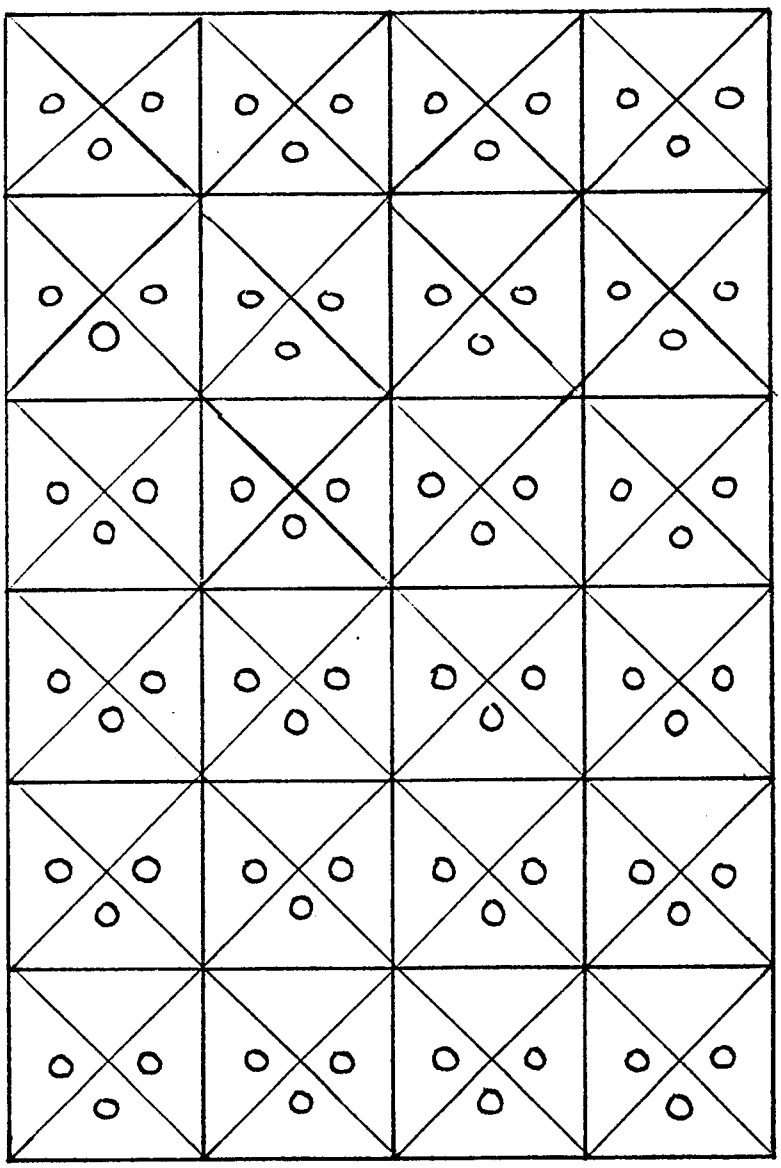
Date: 12-14-81
Sampled by: CTW

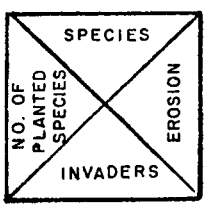
Figure 1.9

irrigated X (both are the same at this time)

non-irrigated X

TMTP-Slope Plots (seeded)





Erosion index

0 - no significant erosion
1 - 1-2 small rills
2 - several small rills
3 - large rill(s) (> 3" wide or 2" deep)
4 - major damage to plot

List invaders by number & species.

Figure 1.10

Date: 12-14-81
Sampled by: CTW